To: Michael Marquess, CEO of Mother Road Brewing Company
From: Still Water Treatment Engineering: Alexander Murphy, Daniel Kennedy, Serenity Helm
Date: December 12, 2022
Subject: Submission of the Final Proposal

Dear Mr. Marquess,

In this letter, we intend to notify you of our team's progress on the wastewater pre-treatment design for Mother Road Brewing Company. Attached to this letter, you will find the team's final proposal detailing project goals, background, technical considerations, scope, and cost of engineering services. Throughout the last four months, our team has been collecting data on the current concentration levels of the contaminants of concern in comparison to City of Flagstaff requirements. From this data, it has been found that biological oxygen demand is consistently in exceedance while total kjeldahl nitrogen is on the rise in concentration. With this consideration, our team will design a pre-treatment process that targets and reduces biological oxygen demand and total kjeldahl nitrogen levels to acceptable permit standards for your company's current production rate.

With this in mind, our team has created a schedule that will allow the production of a successful design by May 8, 2023 which can be found in the attached Gantt chart. The project start date officially began with the first task of conducting research on November 15, 2022 for a total project duration of 81 days. In order for the project to be completed by the targeted end date, the team will require additional personnel and supplies. The total cost of engineering services for this purpose has been summed to $61,580. Should you have any questions or need clarification, please contact us via email.

Sincerely,

Still Water Treatment Engineering

Alexander Murphy, adm528@nau.edu

Daniel Kennedy, dbk44@nau.edu

Serenity Helm, sgh85@nau.edu

Still Water Treatment Engineering

Mother Road Brewing Company
Project Proposal

CENE 476

To: Michael Marquess, CEO
Mother Road Brewing Company

1300 E. Butler Ave.
Flagstaff, Arizona 86001

By: Still Water Treatment Engineering:
Serenity Helm,
Alexander Murphy,
Daniel Kennedy

SUBMITTED:
12/12/2022

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Abbreviation	Definition
BOD	Biological Oxygen Demand
COC	Contaminants of Concern
IBE	Inner Basin Environmental
MRBC	Mother Road Brewing Company
TKN	Total Kjeldahl Nitrogen
TSS	Total Suspended Solids
VSS	Volatile Suspended Solids
HRT	Hydraulic Retention Time
NAU	Northern Arizona University
SE	Senior Engineer
PE	Project Engineer
EIT	Engineer-in-Training
LAB	Lab Technician

1.0 Project Understanding

1.1 Project Purpose

The purpose of this project is to reduce contaminant of concern (COCs) concentrations in the wastewater effluent of Mother Road Brewing Company (MRBC). COC concentrations within MRBC effluent currently exceed pretreatment requirements established by the City of Flagstaff and the Rio De Flag Wastewater Treatment Plant. COCs are Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), and Total Kjeldahl Nitrogen (TKN). Among these COCs, BOD is the most concerning. High concentrations of all COCs have the potential to disturb the wastewater treatment process at Rio De Flag Treatment Plant due to the delicate nature of the wastewater treatment process. Continuing to exceed local wastewater codes will result in the City of Flagstaff fining the MRBC for each month of exceedance. Meeting local standards will prevent financial losses and allow for future process improvements. Furthermore, increasing the environmental sustainability of the brewery's procedures may additionally influence local breweries to adopt a higher standard for their production practices.

1.2 Project Background

1.2.1 Company History

Mother Road Brewing Company was established in 2011 as a craft beer brewery located in Flagstaff, Arizona. Throughout the years, Arizona's demand for MRBC's products has grown, resulting in substantial growth in production volume. MRBC has since grown to meet their growing demand with the opening of a brewing facility separate from their tap room in 2018. This facility, named the Butler Brewery, opened with a production volume of 15,000 barrels per year. As the company has continued their growth, MRBC has increased the volume of their Butler Brewery to 27,000 barrels per year in 2021 making this their dedicated brewing facility and the largest craft brewery in Flagstaff [1].

1.2.2 Location

The MRBC's Butler Brewing facility is located at 1300 E Butler Ave. Figure 1-1 shows Flagstaff in reference to the State of Arizona. Figure 1-2 shows the MRBC Butler Brewery's location in reference to the City of Flagstaff. Figure 1-3 shows MRBC Butler Brewery's location in reference to the local area.

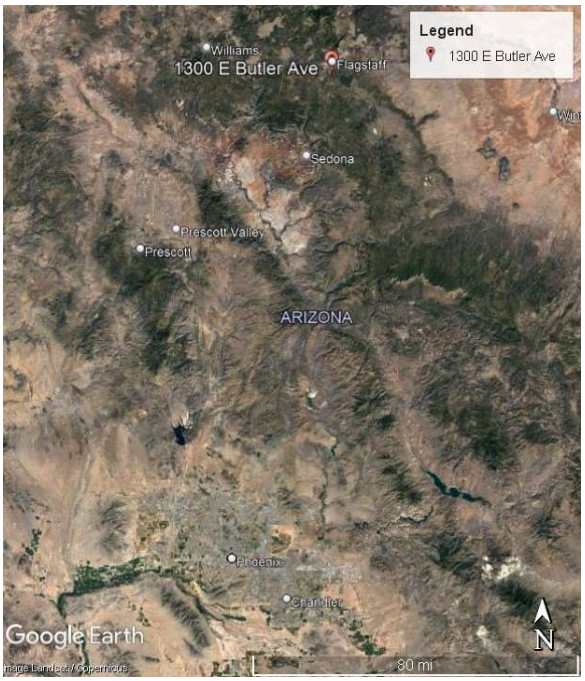


Figure 1- 1: MRBC Location with Respect to Phoenix [1]

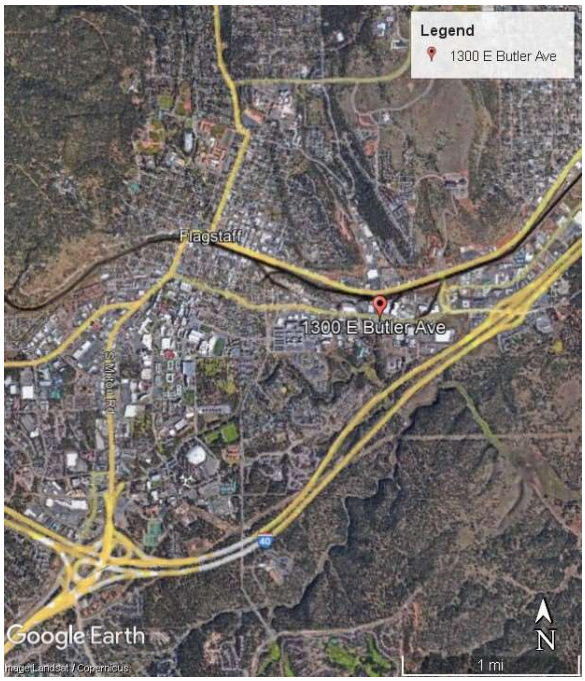


Figure 1- 2: MRBC City Location [1]

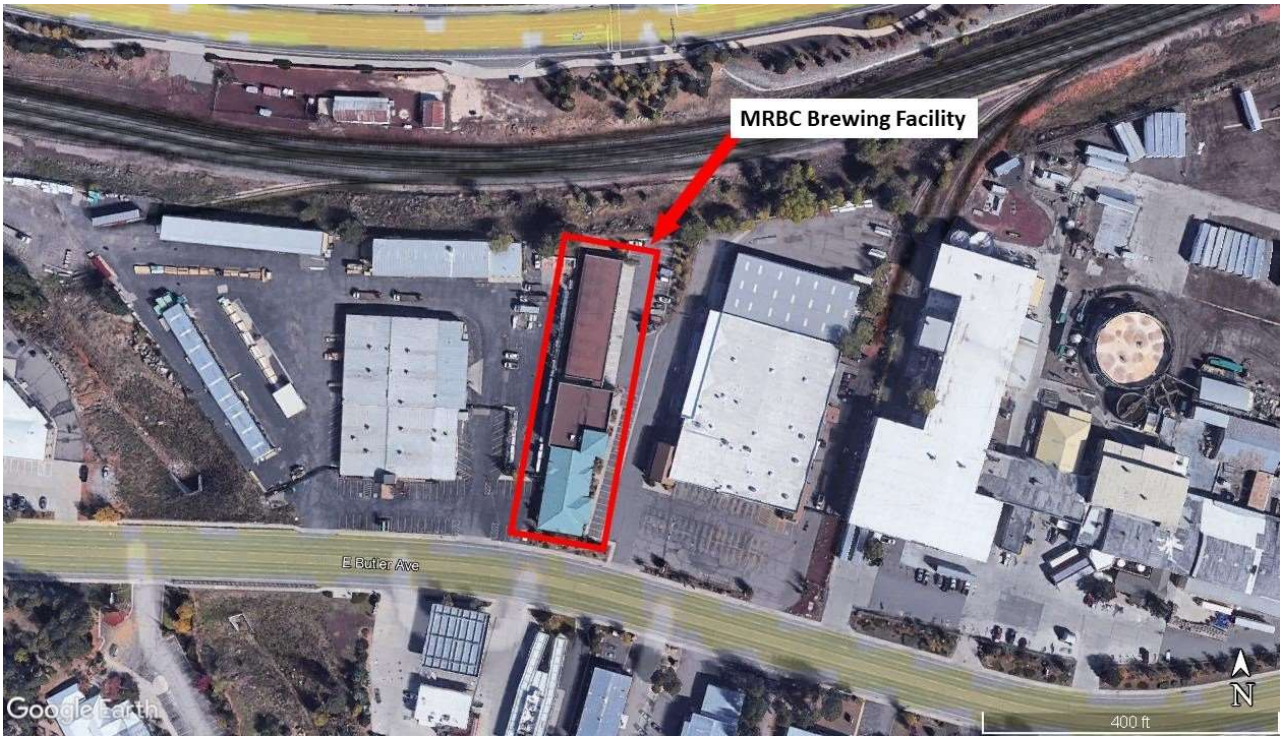


Figure 1- 3: MRBC Brewing Facility [1]

1.2.3 Current Status

Measurements for contaminant levels are being recorded once a week at the MRBC Butler facility testing laboratory. The testing process is conducted by Inner Basin Environmental (IBE) Labs in Flagstaff, Arizona. MRBC's maximum wastewater discharge flow rate is 3,000 gallons/day. Ranges of contaminant levels from August and September and their respective test methods are shown in Table 1-1. Samples are collected and tested on a weekly basis.

Table 1- 1: COC Concentrations Ranges, 2022

Contaminant	Current Concentration (mg/L)	Permit Limit [3] (mg/L)	Test Method
BOD	3,108 – 21,075	8,047*	Standard Method (SM) 5210 B
TSS	444 – 1,104	1,494*	Standard Method (SM) 2540 C
TKN	108 –189	173	EPA 351.2

*This value changes based on the discharge flow rate [2].
Yellow: Concentration is in exceedance

1.3 Technical Considerations

This project will include the following technical aspects.

1.3.1 Codes and Standards

MRBC's wastewater effluent currently exceeds City of Flagstaff permit limits for BOD and TKN concentrations as seen above [Table 1-1]. Therefore, technical work shall include quantifying the extent of violations. Additionally, a complete understanding of the City of Flagstaff's wastewater codes is required in order to understand the extent of wastewater pretreatment requirements.

1.3.2 Pretreatment Methods and Design

Research into existing and novel pretreatment solutions will be conducted. Understanding a wide range of existing wastewater technologies shall further guide development of an MRBC pretreatment alternative. As a design constraint has been communicated regarding size, it is critical that the developed solution maximize efficiency of COC removal whilst minimizing overall footprint. Additionally, different treatment alternatives may require reactors and retention basins engineered to specific volumes to operate efficiently.

Therefore, it will be necessary to consider a combination of existing and emerging technologies to produce a solution that shall meet or exceed project size constraints.

1.3.3 Test Methods

Proper understanding of lab procedures regarding testing of BOD, total suspended solids (TSS), volatile suspended solids (VSS), TKN, phosphates, and chemical oxygen demand (COD) will be reviewed. Current wastewater characteristics are measured weekly and will be provided by MRBC. Although MRBC provides weekly data, the team will be testing a biological solution retrieved from the MRBC's wastewater effluent stream to aid in design considerations. Lab procedures are a resource to quantitatively measure the performance of design prototypes. Quantifying the performance of alternatives will yield additional perspective when selecting a final pretreatment solution.

1.4 Potential Challenges

1.4.1 Project Constraints

One potential challenge that the team will encounter during the project is design space. Space is limited to an 8' x 20' shipping container size; therefore, the design must be compact so that it fits within the designated limits.

Another challenge will be budgeting for materials, tests, or any other items that will be beneficial in the design process. The budget was determined using the requested 18 month return on investment and the monthly fine of $24,000. This means the budget is estimated to be $432,000.

1.4.2 Design Testing

Due to the cadence of this engineering project, testing designs with the development of actual physical scale models may not be productive. This issue shall be addressed by implementing a suite of computer aided design software. These programs will allow the team to conduct models of potential solutions and analyze their effectiveness. This direction shall allow the comparison of multiple virtual designs as opposed to a more limited suite of physical prototypes.

1.4.3 Potential Company Growth

The client has communicated that MRBC intends to grow significantly within the next 10 years. However, this growth cannot be quantified. For this reason, our client has two requests with respect to the pretreatment unit's capacity. One, that the unit be designed for their current maximum wastewater production volume, approximately 3,000 gallons per day. Two, that the unit be developed considering that MRBC may construct additional units according to their needs. Designing a pretreatment unit that is easily replicated and can be implemented as an independent unit or multiple units in configuration will therefore be a challenge to the design team.

1.5 Stake Holders

The main stakeholder in the project is Mother Road Brewing Company as it is vital for their company to satisfy the wastewater treatment effluent requirements following the brewing process. Their customers are also considered stakeholders. The City of Flagstaff and their Rio de Flag Wastewater Treatment Plant is another stakeholder. Wastewater treatment processes account for COC concentrations within their influent, therefore a surge in concentrations may imbalance overall treatment procedures. Consequently, the final stakeholder is the Flagstaff community as a result of the increased burden on wastewater treatment facilities.

2.0 Scope of Services

This section outlines project tasks to successfully meet the project requirements. This includes conducting background research, lab testing, digital modeling, unit design, impact analysis, the project's deliverables, and the overall management of the project.

2.1 Task 1.0: Preliminary Work

This task will consist of obtaining pertinent background information regarding the project.

2.1.1 Task 1.1: Conduct Research

The goal of conducting research is to identify all pertinent information on project technical issues.

2.1.1.1 Task 1.1.1: Research on Effects of BOD, TSS, TKN in Wastewater

Research will be conducted using online databases provided by the NAU Cline Library and Google Scholar applications to obtain articles and journals with useful information regarding the contaminants of concern identified by the project's purpose. This research shall be conducted to identify and discuss the effects relevant COCs have on the wastewater treatment process. Specifically, what negative repercussions would be expected if there were an excess of the listed COCs within wastewater treatment influent.

2.1.1.2 Task 1.1.2: Research on Pretreatment Methods

Research will be conducted through online databases in order to identify the most applicable articles that detail viable wastewater pretreatment methods, including their pros and cons. Specifically, the team will be researching common brewery pretreatment methods as well as novel pretreatment methods in order to have an extensive background on each method to guide future design considerations. One piece of literature shall be taken from the Journal of Cleaner Production [4]. This resource shall yield pertinent information to existing technologies, their efficiencies, and their cost of operation.

2.1.1.3 Task 1.1.3: Research on Codes and Standards

The team will identify current discharge requirements according to the City of Flagstaff industrial wastewater discharge standards. Once the codes and standards are obtained, the team will compare the codes and standards to current concentration levels for COCs.

2.1.1.4 Task 1.1.4: Research on Testing Methods

Research on applicable testing methods regarding COCs (BOD, TKN, TSS), phosphates, COD, and VSS will be completed before testing.

2.1.2 Task 1.2: Identify Existing MRBC Process

The MRBC brewery process will be completely documented. Equipment, process lines, pumps/controllers will be identified with size and capacity information. A complete process block diagram will be created showing all pertinent information. A to-scale diagram of the facility layout will be created from this information.

2.1.3 Task 1.3: Obtain COC Data

The team will gather weekly data produced by the MRBC through the IBE laboratory for COC concentration along with flowrates in order to understand which levels are in exceedance and which contaminant reductions are a priority. The collected data will be from January 2021 through December 2022.

2.2 Task 2.0: Lab Testing

In the case of selecting a biological treatment alternative, COC concentrations must be further tested for VSS, COD, and phosphates. IBE lab test data will be used to track COC concentrations and averages, and maximum concentrations will be used in calculations in Task 3.0. The current IBE data is sufficient for analysis, but the team will conduct testing to check the quality of the IBE test data per the client's suggestion. In addition, the team will test VSS, COD, and phosphate concentrations.

2.2.1 Task 2.1: Creation of a Lab Binder

The team will be preparing a lab binder detailing the test methods, reasons for testing, and health and safety parameters in order to access the NAU laboratories.

2.2.2 Task 2.2: Obtain Samples

The team will develop a sampling plan and collaborate with MRBC to obtain samples that can be used to conduct laboratory tests in Task 2.3.

2.2.3 Task 2.3: Conduct Testing and Analysis

Testing shall be conducted for the treatment efficiency of BOD, COD, TKN, TSS, VSS, and phosphates. Among these tests, TKN and BOD analysis shall be critically evaluated to better summarize overall efficiency since these values are currently in exceedance. These tests shall be performed at NAU's Environmental Engineering Laboratory. The VSS test will inform the team of preexisting biological feed within the sample and will determine the need to add biological feed to the treatment process should there be a lack of organic content. The concentration of phosphates will determine whether a biological treatment system will be sufficient for the project.

2.3 Task 3.0: Treatment Alternatives

The goal of this task is to create in-depth modeling scenarios for three treatment alternatives. From modeling results, a preferred alternative will be selected.

2.3.1 Task 3.1: Identify Technologies

Using background knowledge from Task 1.4, an understanding of which COCs must be reduced and to what extent, and the given lab testing data in Task 2.0, the team will identify pretreatment methods that will best serve the project's purpose.

2.3.2 Task 3.2: Create Screening Decision Matrix for Initial Alternatives

A screening decision matrix with suitable criteria and weighting of each criterion will be developed to evaluate alternatives in Task 3.3.

2.3.3 Task 3.3: Select Alternatives

Technical options identified in Task 3.1 will be combined into five alternatives; these alternatives will be scored against the screening decision matrix to identify three alternatives to be further analyzed in Task 3.6.

2.3.4 Task 3.4: Create Digital Models

This task consists of creating functional mathematical models in Excel or other software to determine the performance of the three alternatives.

2.3.5 Task 3.5: Conduct Model Analysis

This task involves running the models designed above so that data can be collected.

2.3.6 Task 3.6: Create Final Decision Matrix for Selected Alternatives

A final decision matrix with suitable criteria and weighting will be developed to evaluate the three alternatives from Task 3.3.

2.3.7 Task 3.6: Analyze Results and Select a Preferred Alternative

The alternatives will be scored against the final decision matrix from Task 3.6 to select the preferred alternative.

2.4 Task 4.0: Unit Design

A scaled-up design of the preferred alternative will be performed in this task.

2.4.1 Task 4.1: Calculate Operational Parameters and Sizing

Dimensions within wastewater treatment processes weigh heavily on several variables. Therefore, the size of the treatment unit will be formulated with respect to variables such as flow rates, hydraulic retention time (HRT) and the organic loading rate. Proportions and treatment efficiency will also be considered to determine what the overall size of the unit will be. This shall be done by scaling the initial dimensions determined from operation calculations to fit the specified size constraint at the facility. This shall produce the final dimensions of each constituent of the treatment design.

2.4.2 Task 4.2: Material Selection

Selection of materials of construction shall be based on their compatibility with the wastewater streams, availability, and cost.

2.4.3 Task 4.3: Create Final Design Drawings

A digital draft of the final pretreatment unit design will be created with detailed specifications including sizing and other pertinent variables. Additionally, an operation and maintenance manual will be developed.

2.5 Task 5.0: Impact Analysis

This step will analyze the effects of the design based on the triple bottom line (environmental, economic and societal).

2.6 Task 6.0: Deliverables

Deliverables will be provided at 30%, 60%, 90% and 100% project completion.

2.6.1 Task 6.1: 30% Deliverable

The 30% deliverable consists of a report and presentation. The 30% milestone will be the completion of Tasks 1.0-3.3 and will be submitted on February 21, 2023.

2.6.2 Task 6.2 60% Deliverable

The 60% deliverable consists of a report and presentation. The 60% milestone will be the completion of Tasks 3.3-3.7; and will be submitted on March 21, 2023.

2.6.3 Task 6.3: 90% Deliverables

The 90% deliverable consists of a report and website. The 90% milestone will be the completion of Task 4.0 and 5.0. This will be due April 21, 2023.

2.6.4 Task 6.4: Final Project Deliverables

The final deliverable consists of the final report, a presentation, website, and the Operations and Maintenance (O&M) Manual. These will be submitted on May 8, 2023.

2.7 Task 7.0: Project Management

Throughout the project, the team will maintain detailed meeting descriptions along with managing provided resources including cost and materials and will adhere to the schedule outlined in Section 3.0 below. All meetings will be preceded by an agenda 24 hours in advance of the meeting. Meeting minutes will be completed within 24 hours of the meeting. All agendas and minutes will be archived.

2.7.1 Task 7.1: Meetings

Meetings will be scheduled and attended throughout the project to ensure project goals are met and deliverables are completed on time.

2.7.1.1 Task 7.1.1: Client Meetings

Client meetings shall be scheduled as seen fit by the team and client to guarantee the project scope is being met and tasks are being completed on time.

2.7.1.2 Task 7.1.2: Grading Instructor Meetings

Meetings with the grading instructor will consist of ensuring project progress, certifying that objectives are met, and the project is running smoothly.

2.7.1.3 Task 7.1.3: Technical Advisor Meetings

The team will meet biweekly with their technical advisor who will provide necessary assistance, guidance, and technical expertise. The technical advisor will inform the team on deliverable components, any relevant knowledge, and give general advice to enhance the team's work.

2.7.1.4 Task 7.1.4: Team Meetings

Still Water will meet on a weekly basis to work on project deliverables, ensure the team is on track, schedule necessary meetings/appointments, and give project updates. This task will provide the team with the best possible deliverables and project design.

2.7.2 Task 7.2: Schedule Management

Maintenance of the project's schedule is paramount for the project's success. Throughout the project, the team will track scope and schedule progress.

2.7.3 Task 7.3: Resource Management

Over the course of the project, the team will be tracking all resources required for the project, such as staff time and supplies used.

2.8 Exclusions

The team will not be creating a physical model of the selected final design due to time and resource limitations. No other contaminants besides the three identified COCs will be targeted for treatment. In addition to limiting COCs, the extent of the developed design shall only address wastewater effluent produced from current MRBC production (20,000 BBL Beer/year). Therefore, pretreatment design shall not account for the future growth of MRBC.

3.0 Schedule

The project will start on November 15, 2022 and will be completed by May 8, 2023. The total duration of the project is 81 days. A Gantt chart of the schedule has been provided within the appendices and was generated using Microsoft Project.

The critical path for this project consists of Tasks 1.1.4, Task 2.1, Task 2.2, Task 2.3, Task 3.3, Task 3.4, Task 3.5, Task 3.7, Task 4.1, Task 4.3, Task 6.3, and Task 6.4. Tasks 1.1.4 through Task 2.3 limit the team's productivity due to the extensive and time-consuming nature of lab work. This testing must be completed before a design can be decided upon. Tasks 3.3 through Task 3.7 must be completed before Tasks 4.1 through Task 4.3 due to the need for a finalized treatment method before design. Task 6.3 and Task 6.4 summarize the results of the project and thus require the completed design. The team will stay on track by splitting the critical path into the three deliverables with the longer portions effectively having their own deliverable. By constantly referring to the schedule, the team will ensure that all deadlines are met.

4.0 Staffing Plan

4.1 Staffing

The staffing for the project consists of a Senior Engineer (SE), Project Engineer (PE), Engineer in Training (EIT), and Lab Technician (LAB).

4.2 Qualifications

The qualifications for each staff member are as follows:

Senior Engineer: Must have a Bachelor's degree in civil or environmental engineering or an adjacent field [5]. A Master's degree is preferred, but not required. Must have 10 years or more of experience as a professional engineer with a professional engineering license [5]. Proficiency in principles, practices, and methods in related wastewater engineering fields is required [6]. A robust knowledge of wastewater engineering, chemical engineering, and biological engineering is preferred.

Project Engineer: Must have a Bachelor's degree in civil or environmental engineering or an adjacent field [6]. A Master's degree is preferred, but not required. Must have at least four years of experience in an engineering field with a professional engineering license [6]. Must have knowledge in wastewater engineering principles, software applications such as AutoCAD, report writing, and testing methods. Knowledge of chemical and biological engineering principles is preferred.

Engineer in Training: Must have a Bachelor's degree in civil or environmental engineering or an adjacent field [6]. An Engineer-in-Training certificate or the ability to obtain one within one year of hire is required [6]. Proficiency in software including AutoCAD and/or Civil 3D is required.

Lab Technician: High School diploma or equivalent is required. Three years of relevant lab experience is preferred in chemical and/or biological systems. Class D Water/Wastewater Plant Operator's Certification within 1 year of employment and Class B Water/Wastewater Plant Operator's Certifications or the ability to test and obtain is required [6].

4.3 Staffing Plan

A total of 474 hours are estimated to complete the project. Table 4-1 displays the matrix for each staff member with their required paid hours for each task, subtask, and sub-subtask with a total hours column on the right. Total hours for each staff position are in the last row.

Table 4 - 1: Staffing Plan

Task	Senior Engineer (hours)	Project Engineer (hours)	EIT (hours)	Lab (hours)	Total (hours)
Task 1.0: Preliminary Work					61
Task 1.1: Research					
Task 1.1.1: Research on Effects of BOD, TSS, TKN in Wastewater	0	3	10	0	13
Task 1.1.2: Research on Pretreatment Methods	0	3	8	0	11
Task 1.1.3: Research on Codes and Standards	0	3	6	0	9
Task 1.1.4: Research on Testing Methods	0	3	6	3	12
Task 1.2: Identify Existing MRBC Process	0	1	4	0	5
Task 1.3: Obtain COC Data	0	1	6	4	11
Task 2.0: Development of a Biological Treatment Solution					61
Task 2.1: Lab Binder	3	10	10	4	27
Task 2.2: Obtain Samples	0	0	2	0	2
Task 2.3: Testing	0	1	6	25	32
Task 3.0: Treatment Alternatives					65
Task 3.1: Identify Technologies	0	8	6	0	14
Task 3.2: Create Decision Matrix for Initial Alternatives	2	2	0	0	4
Task 3.3: Select Alternatives	1	1	0	0	2
Task 3.4: Create Digital Models	0	8	20	0	28
Task 3.5: Conduct Model Analysis	0	3	8	0	11
Task 3.6: Create Decision Matrix for Selected Alternative/Design	2	2	0	0	4
Task 3.7: Analyze Results and Select a Preferred Alternative	1	1	0	0	2
Task 4.0: Unit Design					80
Task 4.1: Operational Parameters and Sizing	2	15	10	0	27
Task 4.2: Material Selection	1	10	6	0	17
Task 4.3: Final Design Drawings	6	20	10	0	36
Task 5.0: Impact Analysis	2	3	2	1	8
Task 6.0: Deliverables					56
Task 6.1: 30% Deliverables	2	5	5	0	12

Task 6.2 60% Deliverables	2	5	5	0	12
Task 6.3: 90% Deliverables	2	5	5	0	12
Task 6.4: Final Project Deliverables	4	10	6	0	20
Task 7.0: Project Management					143
Task 7.1: Meetings					
Task 7.1.1: Client Meetings	5	5	5	0	15
Task 7.1.2: Grading Instructor Meetings	0	5	5	0	10
Task 7.1.3 Technical Advisor Meetings	2	10	10	4	26
Task 7.1.4 Team Meetings	20	20	20	20	80
Task 7.2: Schedule Management	2	3	1	0	6
Task 7.3: Resource Management	2	3	1	0	6
Summary					
Total (hours)	61	169	183	61	474

5.0 Cost of Engineering Services

The total cost of the project is about $62,000 with the cost breakdown shown in Table 5-1. Personnel costs include benefits, overhead, and profit. NAU EnE lab access is a flat fee of $100 per day. The team will need access to the lab for forty-four days throughout the project in order to test and store the samples as well as have access to software for design tasks. This table also communicates the cost of non-consumable material and consumable material that will be used throughout testing. Lab PPE is considered a non-consumable since it includes lab coats and goggles while the gloves will be provided in the laboratory. There are four units of PPE considered since our technical advisor, Dr. Diana Calvo, will be joining the team for testing.

Table 5 - 1: Cost of Engineering Services

Cost of Engineering Services			
Personnel			
Position	**Hours**	**Dollars/Hour**	**Dollars**
Senior Engineer	**61**	**$218/hr**	**$13,286**
Project Engineer	**169**	**$134/hr**	**$22,629**
Engineer in Training	**183**	**$94/hr**	**$17,047**
Lab Technician	**61**	**$68/hr**	**$4,099**
		Sub Total	**$57,061**
Lab Access			
Non-Consumable	**Units**	**Dollars/Unit**	**Dollars**
NAU EnE Lab Rental	**44**	**$100/Unit**	**$4,400**
Lab PPE	**4**	**$50/Unit**	**$200**

		Sub Total	**$4,400**
Cost of Consumables			
Consumable	**Cost/Unit**	**Unit/Test**	**Cost/Test**
Lithium Hydroxide, powder pillow	**$1.12**	**6**	**$6.69**
Grease, stopcock, tube	**$0.00**	**1**	**$0.00**
BOD Nutrient Buffer Pillow	**$0.59**	**1**	**$0.59**
COD, Low Range, 3-150 mg/L	**$3.37**	**2**	**$6.73**
COD, High Range, 20-1500 mg/L	**$3.32**	**2**	**$6.63**
COD, High Range Plus, 200-15,000 mg/L	**$3.32**	**2**	**$6.63**
PhosVer 3 Phosphate Reagent Powder Pillow	**$0.77**	**1**	**$0.77**
Nitrogen Reagent Set	**$1.18**	**1**	**$1.18**
Filter Disk, glass fiber, 47mm	**$0.59**	**1**	**$0.59**
		Cost for 4 Test	**$119.25**
Summation			
		Total	**$61,580**

6.0 References

[1] Google, "Google Earth," The Alphabet Company, 2022.

[2] City of Flagstaff, "Chapter 7-02 Wastewater Reglations," 2022. [Online]. [Accessed 3 October 2022].

[3] Mother Road Brewing Company, "Mother Road Brewing Company," Mother Road Brewing CO, Flagstaff, AZ, 2021.

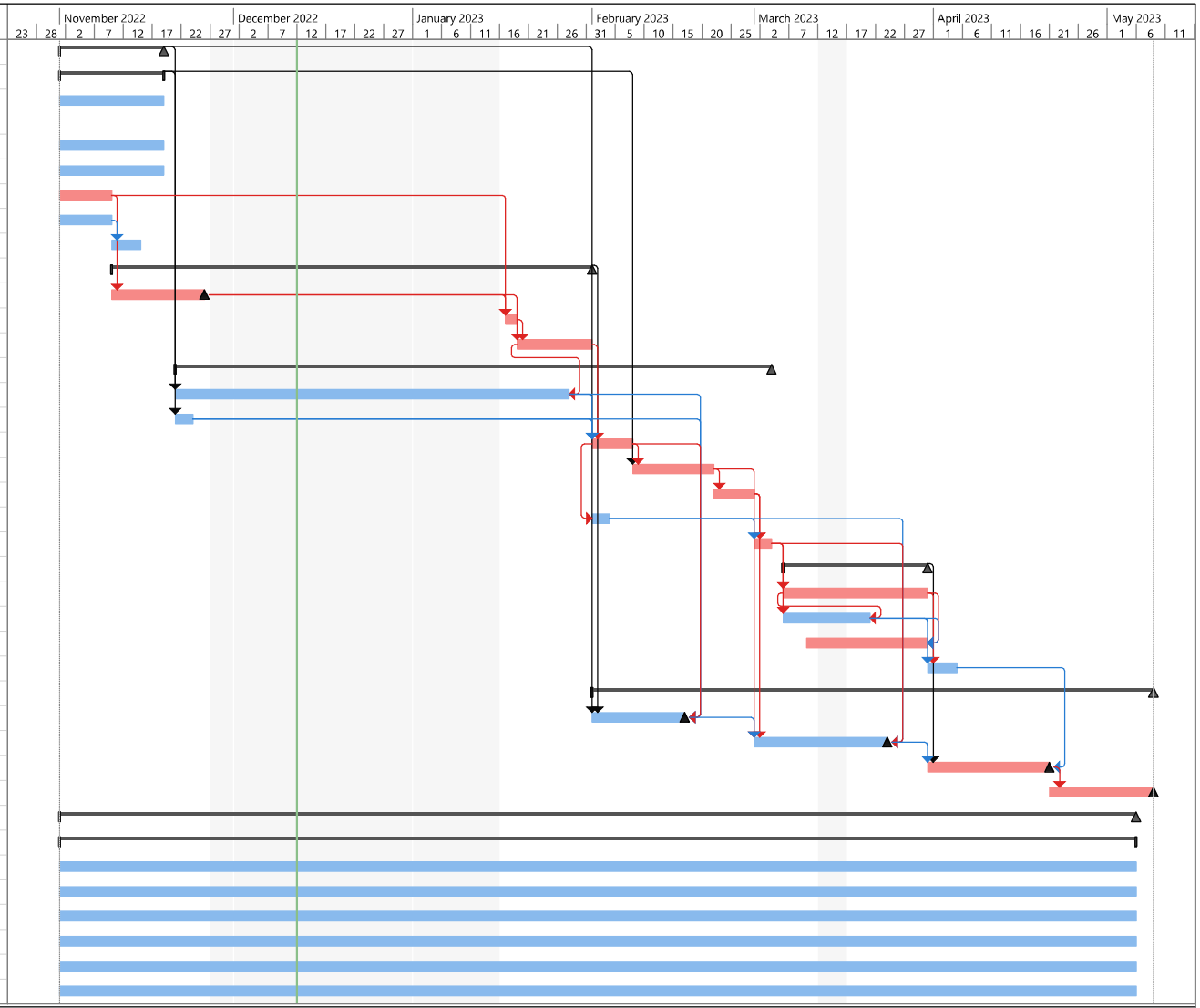
[4] L. Fillaudeau, P. Blanpain-Avet and G. Daufin, "Water, wastewater and waste management in brewing industries," *Journal of cleaner production,* vol. Vol.14, pp. p.463-471, 2006.

[5] "What Does a Senior Engineer Do?," CLIMB, 02 November 2022. [Online]. Available: https://climbtheladder.com/senior-engineer/. [Accessed 10 November 2022].

[6] "Wastewater Senior Engineer Job Search," Indeed, [Online]. Available: https://www.indeed.com/jobs?q=Wastewater+Senior+Engineer&l=&vjk=53201ad756a103c3. [Accessed 10 November 2022].

Appendices

ID	Task Mode	Task Name
1		**Task 1.0: Preliminary Work**
2		**Task 1.1: Research**
3		Task 1.1.1: Research on Efffects of BOD, TSS, TKN in Wastewater
4		Task 1.1.2: Research on Pretreatment Methods
5		Task 1.1.3 Research on Codes and Standards
6		Task 1.1.4: Research on Testing Methods
7		Task 1.2: Identify Existing MRBC Processes
8		Task 1.3: Obtain COC Data
9		**Task 2.0: Lab Testing**
10		Task 2.1: Lab Binder
11		Task 2.2: Obtain Samples
12		Task 2.3: Testing
13		**Task 3.0: Digital Modeling of Alternatives**
14		Task 3.1: Identify Technologies
15		Task 3.2: Create Decision Matrix for Initial Alternatives
16		Task 3.3 Select Alternatives
17		Task 3.4: Create Digital Models
18		Task 3.5: Conduct Model Analysis
19		Task 3.6: Create Decision Matrix for Selected Alternative/Design
20		Task 3.7: Analyze Results and Select Preferred Alternative
21		**Task 4.0: Unit Design**
22		Task 4.1: operational Parameters and Sizing
23		Task 4.2: Materials Selection
24		Task 4.3: Computer Aided Final Design
25		Task 5.0: impact Analysis
26		**Task 6.0: Deliverables**
27		Task 6.1: 30% Deliverable
28		Task 6.2: 60% Deliverable
29		Task 6.3: 90% Deliverable
30		Task 6.4: Final Project Deliverables
31		**Task 7.0: Project Management**
32		**Task 7.1: Meetings**
33		Task 7.1.1: Client Meetings
34		Task 7.1.2: Grading Instructor Meetings
35		Task 7.1.3: Technical Advisor Meetings
36		Task 7.1.4: Team Meetings
37		Task 7.2: Schedule Management
38		Task 7.3: Resource Management



Project: old copy Capstone sche
Date: Mon 12/12/22

Task	Project Summary	Manual Task	Start-only	Deadline	Manual Progress		
Split	Inactive Task	Duration-only	Finish-only	Critical			
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Critical Split			
Summary	Inactive Summary	Manual Summary	External Milestone	Progress			